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Managing Volunteer Potato (*Solanum tuberosum*) in Field Corn (*Zea mays*) with Carfentrazone-Ethyl and Dicamba[1]

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Abstract: Volunteer potato is a perennial weed that is difficult to control in crop rotations. Field studies were conducted near Paterson, WA, in 2001 and 2002 to evaluate the control of volunteer potato with carfentrazone-ethyl and dicamba in field corn. When potatoes were not controlled corn yield was reduced 23 and 62% in 2001 and 2002, respectively. Single postemergence (POST) applications of carfentrazone-ethyl at 9 g/ha killed exposed foliage of potato, but new shoots continued to emerge both years and reduced corn yield in 2002. The most effective treatments tested were a single mid-postemergence application of carfentrazone-ethyl plus dicamba (9 + 280 g/ha), two applications of carfentrazone-ethyl alone at early postemergence and late postemergence, and three POST applications of carfentrazone-ethyl, which controlled volunteer potato 77 to 87% in early June, reduced weight of tubers produced by 76 to 96% compared with nontreated checks, and prevented corn yield loss compared with hand-weeded checks. Herbicide treatments reduced potato tuber weight more than tuber number.

Nomenclature: Carfentrazone-ethyl; dicamba; field corn, *Zea mays* L.; potato, *Solanum tuberosum* L. 'Russet Burbank'.

Additional index words: Groundkeeper (volunteer potato).

Abbreviations: EPOST, early postemergence; LPOST, late postemergence; MPOST, mid-postemergence; POST, postemergence.

INTRODUCTION

Volunteer potato infests numerous rotation crops in regions where mild winter temperature fails to kill tubers left after potato harvest. When not controlled, volunteer potato harbors insects, diseases, and nematodes that can infest neighboring or future potato crops (Ellis 1992; Thomas 1983; Wright and Bishop 1981). Field corn is a common rotation crop with potato in many potato production areas. Boydston (2001) reported control of volunteer potato with several herbicides and cultivation in field corn. In these studies, atrazine applied preemergence followed by dicamba plus 2,4-D postemergence (POST) and cultivation reduced weight of new tubers produced by greater than 95% in field corn. Atrazine alternatives are needed because atrazine is slow to degrade and has potential to contaminate groundwater. Dicamba is often applied POST for volunteer potato suppression in corn, but potato often continues to produce daughter tubers after dicamba treatment (Boydston 2001).

Carfentrazone-ethyl was recently registered for POST broadleaf weed control in field corn. Carfentrazone-ethyl is currently being evaluated for use as a potato desiccant (P. Hutchinson and N. Sladen, personal communication) and may be useful for volunteer potato suppression in field corn. Weed control with carfentrazone-ethyl is achieved primarily by contact action (Anonymous 1998; Dayan et al. 1997). Volunteer potatoes are able to resprout numerous times from individual tubers, and multiple shoot removal events are usually required to reduce competition with the main crop and reduce new tuber production (Boydston and Seymour 2002; Williams and Boydston 2002). Dicamba is a common POST-applied herbicide used to suppress volunteer potato in corn. Dicamba is translocated to daughter tubers, and injury is often evident in shoots arising from daughter tubers (Wall 1994).

Volunteer potato control with carfentrazone-ethyl has not been investigated, and these studies were conducted to evaluate volunteer potato control in field corn with single and multiple applications of carfentrazone-ethyl.

MATERIALS AND METHODS

Trials were conducted in 2001 and 2002 in field corn grown under center pivot irrigation in south-central

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Washington on a Quincy (Typic Torripsamments) sand. In 2001, a natural infestation of volunteer potato was present at a density of 3.5 plants/m^2, which had overwintered from volunteer potato that were present in the previous crop of winter wheat (*Triticum aestivum* L.), which followed a potato crop planted in 1999. In 2002, potato tubers, var. 'Russet Burbank', were planted on April 3, 2002, to simulate volunteer potato. Potato was planted in two rows spaced 85 cm to obtain a final density of 5.7 plants/m row (7.5 plants/m^2) near the two center rows of corn in each four-row plot. Corn, var. 'Pioneer 3655', was planted on April 20, 2001, and April 16, 2002, to obtain a final density of 80,000 plants/ha in rows spaced 76 cm. Dimethenamid-P, which does not affect potato, was applied preemergence at 0.7 kg/ha to the entire trial to control annual weeds in both years. Trials were kept free of additional weeds by hand weeding.

Plots were 6 by 9 m and treatments replicated three times in a randomized complete block design. Herbicides were applied with a bicycle sprayer equipped with flat-fan nozzles and operated at a pressure of 186 kPa in a total volume of 187 L/ha. Carfentrazone-ethyl was evaluated at 9 g ai/ha applied one, two, or three times alone or as a single application combined with dicamba at 280 g ae/ha. A dicamba control at 280 g/ha, hand-weeded control, and nontreated control were included for comparison. Emerged potato shoots were removed weekly in hand-weeded controls for 5 wk after corn planting and then removed every 2 wk for the remainder of the season. All herbicide solutions included a nonionic surfactant[3] at 0.5% (v/v) spray solution. In 2001, herbicides were applied on May 2 (early postemergence [EPOST]), May 9 (mid-postemergence [MPOST]), and May 18 (late postemergence [LPOST]) when field corn was one- to two-, three- to four-, and five- to six-leaf stages, respectively. In 2002, herbicides were applied on May 8, May 15, and May 24 when field corn was in the two- to three-, three- to four-, and five- to six-leaf stages, respectively. Most potato shoots were 7 to 11 cm tall at the EPOST application date during both years and 15 to 18 cm tall at the time of the MPOST applications. Potato tuber initiation was just beginning at the time of the MPOST application date in both years, with some plants having 4-mm-diam tubers. All applications made at the LPOST stage were repeat applications, so potato height varied depending on the effectiveness of the initial treatment.

[3] R-11 nonionic surfactant containing octyl phenoxy polyethoxy ethanol, isopropanol, and compounded silicone, Wilber-Ellis Co., P.O. Box 16458, Fresno, CA 93755.

Volunteer potato control was visually rated on a scale of 0 = no control to 100 = complete control in early June in both years. Corn injury was rated visually on a scale of 0 = no injury to 100 = dead in early June each year. In 2001, 10 potato plants were marked in each plot early in the season. In September, tubers from marked plants were dug, and number and weight of tubers were recorded. Because potato was planted in rows in 2002 to simulate volunteer potato, tubers were dug from 3 m of row in September. Corn was machine harvested and shelled from 9 m of the two center rows in each plot and weighed.

Data from both years were combined and subjected to ANOVA. There was a significant year effect for all measured variables and a significant year by treatment effect, so data from each year were analyzed separately. Treatment means were separated by Fisher's protected LSD procedure at $\alpha = 0.05$.

RESULTS AND DISCUSSION

Carfentrazone-ethyl applied to potato at all growth stages tested caused necrotic lesions on foliage within 24 h after application, and 95% or more of the foliage exposed at the time of herbicide application eventually died. Carfentrazone-ethyl slightly injured field corn, resulting in necrotic speckling on leaves exposed at the time of herbicide application.

Although carfentrazone-ethyl desiccated most of the potato foliage exposed during each application, new shoots emerged from the seed piece within 3 to 5 d. As a result, little or no potato control was evident in early June from single applications of carfentrazone-ethyl applied in early May of both years (Table 1). One application of carfentrazone-ethyl applied to potato at the time of tuber initiation (MPOST) controlled potato in early June slightly better than a single application of carfentrazone-ethyl applied 1 wk earlier (EPOST).

Carfentrazone applied once MPOST or twice at EPOST and MPOST controlled potato 40 to 48% in 2002 and only 17% in 2001 (Table 1). Cloudy conditions existed 2 d before MPOST applications in 2002, limiting total daily solar radiation to 330 Langleys, whereas 549 Langleys were received in 2001. Thompson and Nissen (2002) reported that low light intensity before carfentrazone-ethyl application increased injury to soybean [*Glycine max* (L.) Merr] and wheat.

Carfentrazone-ethyl applied twice, at EPOST and MPOST, did not control potato as well as carfentrazone-ethyl applied twice at EPOST and LPOST in both years (Table 1). Delaying the second application of carfentra-

Table 1. Volunteer potato control and number and weight of tubers produced after postemergence applications of carfentrazone and dicamba in field corn in 2001 and 2002 at Paterson, WA.[a]

Treatment	Timing[b,c]	Rate	Potato control[d] 2001	Potato control[d] 2002	Number of tubers 2001	Number of tubers 2002	Total weight of tubers 2001	Total weight of tubers 2002
		g/ha	%	%	% nontreated checks			
Carfentrazone-ethyl	EPOST	9	0	3	71	97	52	89
Carfentrazone-ethyl	MPOST	9	17	40	50	104	30	60
Carfentrazone-ethyl	EPOST + MPOST	9 + 9	17	48	56	89	40	48
Carfentrazone-ethyl	EPOST + LPOST	9 + 9	77	86	47	55	19	22
Carfentrazone-ethyl	EPOST + MPOST + POST	9 + 9 + 9	82	87	37	48	16	15
Carfentrazone-ethyl + dicamba	MPOST	9 + 280	87	86	26	96	4	24
Dicamba	MPOST	280	80	81	40	90	12	33
Nontreated[e]			0	0	—	—	—	—
Hand weeded			100	100	0	1	0	0
$LSD_{(0.05)}$			8.3	9.1	20.9	21.4	17.7	11.9

[a] Data from 2001 and 2002 were not combined because of a significant treatment by year interaction.

[b] Abbreviations: EPOST, early postemergence; MPOST, mid postemergence; LPOST, late postemergence.

[c] EPOST applied on May 2, 2001, and May 8, 2002; MPOST applied on May 9, 2001, and May 15, 2002; and LPOST applied on May 18 and May 24, 2002.

[d] Volunteer potato control was visually estimated on June 1, 2001, and June 2, 2002.

[e] Nontreated checks contained 36 and 51 tubers/m² weighing 2,929 and 4,226 g in 2001 and 2002, respectively.

zone-ethyl to 16 d after the first application rather than 7 d allowed less time for plants to recover between the final application and the time of evaluation. Delaying the second application of carfentrazone-ethyl also decreased the time allowed for plants to recover and produce new shoots between the final application and harvest. In both years, three sequential applications of carfentrazone-ethyl at 7- to 9-d intervals controlled potato in early June similar to two applications of carfentrazone-ethyl 16 d apart (Table 1).

A single application of carfentrazone-ethyl plus dicamba at EPOST controlled potato about 86% in early June in both years, similar to control with dicamba alone applied at the same stage of potato growth or three sequential applications of carfentrazone-ethyl alone (Table 1). Colorado potato beetle (*Leptinotarsa decemlineata* Say) larvae infested plots in both years and severely defoliated remaining potato foliage in all treatments by late July.

Potatoes in nontreated plots produced 36 and 51 tubers/m² in 2001 and 2002, respectively (Table 1). In 2001, all herbicide treatments reduced the number of new tubers produced, ranging from 26 to 71% of nontreated checks (Table 1). The most effective treatments, i.e., carfentrazone-ethyl plus dicamba and three sequential applications of carfentrazone-ethyl, reduced the number of new tubers to 26 and 37% of nontreated checks, respectively, whereas dicamba alone reduced the number of new tubers to 40% of nontreated checks. Potatoes treated with one or two applications of carfentrazone-ethyl in 2001 produced 47 to 71% of the number of tubers in nontreated checks.

In 2002, only carfentrazone-ethyl applied twice 16 d apart and carfentrazone-ethyl applied three times reduced the number of new tubers produced compared with nontreated checks (Table 1). Potato receiving these two treatments produced about half as many new tubers as plants in nontreated checks, whereas plants in all remaining treatments produced a similar number of tubers as nontreated checks. Although carfentrazone applied at MPOST visually controlled potato better in 2002 than in 2001, tuber number or weight was not reduced in 2002 as it was in 2001. In 2002, potato tubers were planted from commercial seed to simulate volunteer potato and may have had a greater capacity to resprout after killing emerged shoots compared with the natural infestation of volunteer potato that was present in 2001.

Potato tuber weight was reduced more than tuber number when treating with POST-applied herbicides, as reported in previous studies (Boydston 2001). Potatoes in nontreated checks produced 2,929 and 4,226 g tubers/m² in 2001 and 2002, respectively (Table 1). In 2001, potatoes treated with carfentrazone-ethyl applied once at EPOST, twice at EPOST and LPOST, or three times produced 52, 19, and 16% of the weight of tubers in nontreated checks (Table 1). In 2002, carfentrazone-ethyl applied once at EPOST, twice at EPOST and LPOST, or three times reduced tuber weight to 89, 22, and 15% of nontreated checks (Table 1). Carfentrazone-ethyl plus dicamba applied MPOST reduced tuber weight to 4 and

Table 2. Field corn injury and yield after postemergence applications of carfentrazone and dicamba for volunteer potato control in 2001 and 2002 at Paterson, WA.[a]

Treatment	Timing[b,c]	Rate	Corn injury[d] 2001	Corn injury[d] 2002	Corn yield 2001	Corn yield 2002
		g/ha	%	%	kg/ha	kg/ha
Carfentrazone-ethyl	EPOST	9	7	2	11,740	8,660
Carfentrazone-ethyl	MPOST	9	3	4	13,170	10,630
Carfentrazone-ethyl	EPOST + MPOST	9 + 9	3	5	11,290	12,210
Carfentrazone-ethyl	EPOST + LPOST	9 + 9	10	11	13,310	13,950
Carfentrazone-ethyl	EPOST + MPOST + LPOST	9 + 9 + 9	8	11	13,010	14,120
Carfentrazone-ethyl + dicamba	MPOST	9 + 280	4	4	12,640	12,990
Dicamba	MPOST	280	8	0	13,990	12,260
Nontreated			—	—	10,550	5,470
Hand weeded			—	—	13,690	14,380
$LSD_{(0.05)}$			5.5	1.4	2,073	2,177

[a] Data from 2001 and 2002 were not combined because of a significant treatment by year interaction.

[b] Abbreviations: EPOST, early postemergence; MPOST, mid postemergence; LPOST, late postemergence.

[c] EPOST, applied on May 2, 2001, and May 8, 2002; MPOST applied on May 9, 2001, and May 15, 2002; and LPOST applied on May 18 and May 24, 2002.

[d] Corn injury was visually estimated June 1, 2001, and June 2, 2002.

24% of nontreated checks in 2001 and 2002, respectively (Table 1). One application of dicamba reduced tuber weight to 12 and 33% of nontreated checks in 2001 and 2002, respectively. Reducing tuber weight may be important in reducing fitness of volunteer potato in subsequent years and increasing susceptibility of volunteer potato to control measures. Lutman (1977) reported that plants produced from smaller tubers had lower vigor than plants from larger tubers, and these were easier to control with metoxuron. Stem number and tuber yield potential of potato increase as tuber size increases (Iritani et al. 1972; Wakankar 1944).

The presence of noncontrolled volunteer potato visually stunted field corn growth (data not shown) and reduced corn yield 23 and 62% in 2001 and 2002, respectively, compared with hand-weeded checks, which yielded 13,690 and 14,380 kg/ha, respectively (Table 2). The greater impact of volunteer potato on corn yield in 2002 was probably the result of both a greater density of potato and planting potato in rows in close proximity to corn rows.

In both years, poor potato control generally resulted in lower corn yield as evidenced by low corn yields in plots treated with single applications of carfentrazone-ethyl applied at the EPOST stage of potato growth and two applications of carfentrazone-ethyl applied at EPOST and MPOST (Table 2). In both years, two applications of carfentrazone-ethyl applied at EPOST and LPOST or three applications of carfentrazone-ethyl suppressed potato growth enough to prevent yield loss in corn compared with hand-weeded checks. Yield of corn treated with a single application of dicamba alone or carfentrazone-ethyl plus dicamba was also equal to hand-weeded checks in both years. Visual corn injury from treatments containing dicamba was less than 10% in both years (Table 2).

Carfentrazone-ethyl applied POST twice at 16 d apart or three times POST was effective in suppressing volunteer potato in field corn and preventing yield loss in corn. However, carfentrazone-ethyl failed to prevent new potato shoots from emerging and new tubers from being produced, which would perpetuate the weed in future years. Carfentrazone-ethyl failed to prevent potato from resprouting, allowing potato to provide a host for diseases, nematodes, and insects, partially defeating the purpose of crop rotation. Late-season defoliation by Colorado potato beetle likely reduced new tuber production after all herbicide treatments. In the absence of Colorado potato beetles carfentrazone-ethyl treatments may not be as effective in suppressing volunteer potato season long.

Dicamba and carfentrazone-ethyl plus dicamba applied once MPOST reduced potato tuber number in one of 2 yr, prevented corn yield loss, and reduced the weight of new potato tubers produced in both years. The smaller average tuber weight resulting from dicamba treatment may make these tubers less fit and more susceptible to control tactics the following year. Treatments containing dicamba required only single applications to achieve volunteer potato suppression and maintain corn yield and may be preferable to two or more applications required with carfentrazone-ethyl because of fewer trips over the field and possibly lower cost.

Cultivation after POST-applied herbicides reduced the number of new potato tubers produced compared with herbicides alone (Boydston 2001). Combining carfentrazone-ethyl with translocated herbicides active on volunteer potato or cultivation may provide additional control of this problem weed.

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LITERATURE CITED

Anonymous. 1998. Aim product label. Philadelphia, PA: FMC Corp., Agricultural Products Group. 11 p.

Boydston, R. A. 2001. Volunteer potato (*Solanum tuberosum*) control with herbicides and cultivation in field corn (*Zea mays*). Weed Technol. 15: 461–466.

Boydston, R. A. and M. D. Seymour. 2002. Volunteer potato (*Solanum tuberosum*) control with herbicides and cultivation in onion (*Allium cepa*). Weed Technol. 16:620–626.

Dayan, F. E., S. O. Duke, J. D. Weete, and H. G. Hancock. 1997. Selectivity and mode of action of carfentrazone-ethyl, a novel phenyl triazolinone herbicide. Pestic. Sci. 51:65–73.

Ellis, P. J. 1992. Weed hosts of beet western yellows virus and potato leafroll virus in British Columbia. Plant Dis. 76:1137–1139.

Iritani, W. M., R. Thornton, L. Weller, and G. O'Leary. 1972. Relationships of seed size, spacing, stem numbers to yield of Russet Burbank potatoes. Am. Potato J. 49:463–469.

Lutman, P.J.W. 1977. The effect of tuber size on the susceptibility of potatoes to metoxuron. Potato Res. 20:331–335.

Thomas, P. E. 1983. Sources and dissemination of potato viruses in the Columbia Basin of the Northwestern United States. Plant Dis. 67:744–747.

Thompson, W. M. and S. J. Nissen. 2002. Influence of shade and irrigation on the response of corn (*Zea mays*), soybean (*Glycine max*), and wheat (*Triticum aestivum*) to carfentrazone-ethyl. Weed Technol. 16:314–318.

Wakankar, S. M. 1944. Influence of size and seed piece upon the yield of potatoes. J. Am. Soc. Agron. 36:32–36.

Wall, D. A. 1994. Potato (*Solanum tuberosum*) response to simulated drift of dicamba, clopyralid, and tribenuron. Weed Sci. 42:110–114.

Williams, M. M., II and R. A. Boydston. 2002. Effect of shoot removal during tuberization on volunteer potato (*Solanum tuberosum*) tuber production. Weed Technol. 16:617–619.

Wright, G. C. and G. W. Bishop. 1981. Volunteer potatoes as a source of potato leafroll virus and potato virus X. Am. Potato J. 58:603–609.